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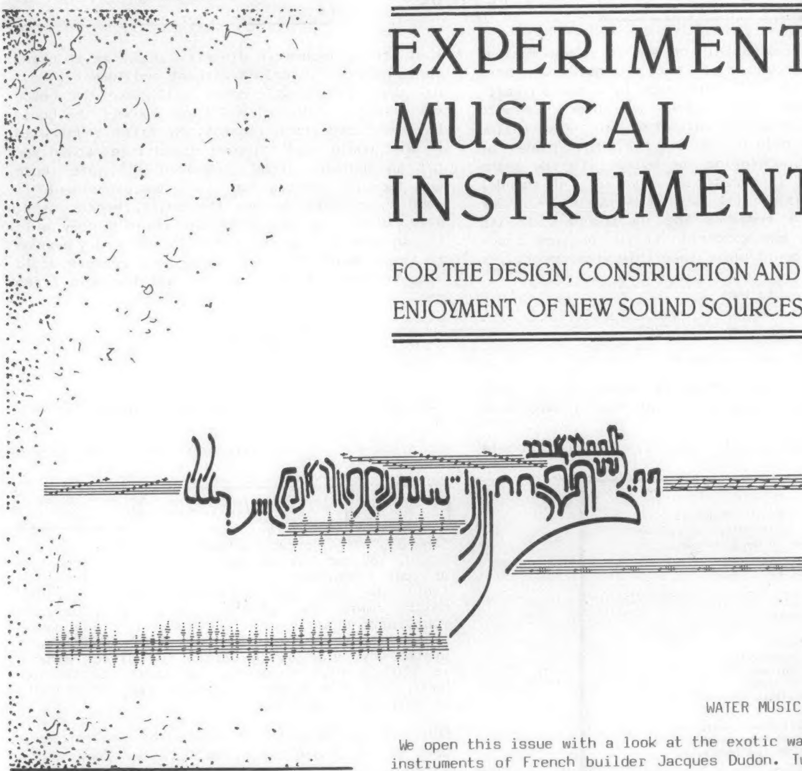
EXPERIMENTAL MUSICAL INSTRUMENTS

FOR THE DESIGN, CONSTRUCTION AND ENJOYMENT OF NEW SOUND SOURCES



WATER MUSIC, LIGHT MUSIC

We open this issue with a look at the exotic water and light instruments of French builder Jacques Dudon. Two more major pieces appearing this time around are an article on a note-worthy new design for chromatic orchestral flute made by Jim Schmidt, and a collection of writings on travel instruments, looking at the many and various approaches people have taken over the years to making music more portable. The flute article starts on page 9; travel on page 12. Water and light start right here.

IN THIS ISSUE

Score reproduced above made by Darrell DeVore

AN ENCOUNTER WITH JACQUES DUDON
by Tom Nunn

This summer I got a phone call from Bart Hopkin saying a musician and instrument maker from France had contacted him and was coming to California for a visit. Bart suggested this person might be willing to do a program in my concert series, "New Instruments/New Music." This, indeed, worked out, and that is how I met Jacques Dudon.

After meeting Jacques and learning about his work designing and building numerous water instruments, as well as his most recent development of an amazing instrument he calls the photosonic synthesizer, I decided EMI readers should know about it. So I interviewed Jacques one evening in

(continued on page 4)

LETTERS

A FRIEND OF OURS SAID he was at a huge musical instrument convention in Chicago about four years ago and saw the following made by a man in California: A basketball-sized & -shaped ceramic instrument with a 2-3" diameter hole on one side and a smaller hole on the other which is played by covering and uncovering the holes with the palms of the hands. It could make a variety of sounds, our friend said, and sold for about $70. Our friend doesn't remember the instrument's or its maker's name. Was wondering if you or your readers had ever heard of or seen this instrument...

Liz Was
1341 Williamson
Madison, WI 53703

I HAVE RECENTLY BEGUN to subscribe to your newsletter and I have a project that I need some help with.

I have discovered some "timpani-like" bowls that are 63 inches in diameter and I am thinking about making the world's largest and lowest timpani. Remo drum head company will make the heads out of mylar (plastic) and I can connect the bowls to hand-tuned chain timpani. My first inquiry is -- what would a 63" timpani sound like? Could you get an audible pitch? Second of all, are there any funding sources for such an experiment? I need about $3000 to buy the bowls, heads, hardware, etc. I am presently the world's only solo timpanist and I may be the only one crazy enough to think about this, but maybe your readers would also be interested. I can use all the help I can get.

Jonathan L. Haas
142 West End Avenue, Apt. 15 M
New York, NY 10023

P.S. Wendy Chambers is writing a piece for 100

(Continued lower half next page)

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NOTICES/EVENTS

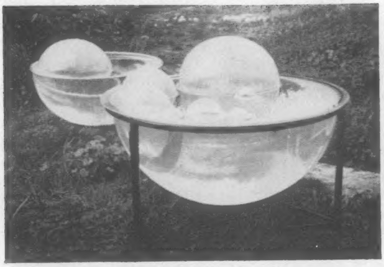
"THE BUG" -- A Portable Electroacoustic Percussion Board. You can have a whole percussion orchestra at your fingertips in the space of only 2 square feet! The Bug, with its assortment of rods, nails, combs, springs and strings, will delight your ear and amaze your friends and fellow musicians. Almost any contact mic and amplification system may be used. The price for direct orders is $200.00 plus shipping. To order, write Tom Nunn, 3016-25th Street, San Francisco, CA 94110, or call (415) 282-1562.

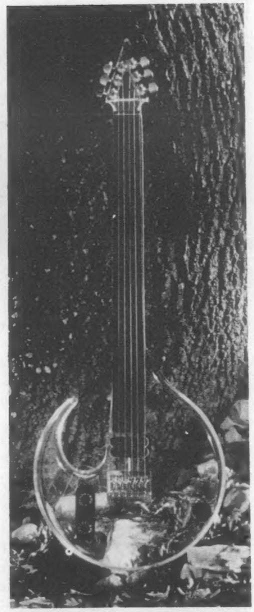
SOUND CHOICE MAGAZINE is created by and for members of the Audio Evolution Network. Each hefty issue contains hundreds of informed reviews of unusual recordings and publications from around the world. Contact addresses help you get in touch with the artists and publishers. Sample copy: $2.50. Money back guarantee if not satisfied. Write Sound Choice, PO Box 1251, Ojai, CA 93023, USA.

Several events involving new instruments are coming up in the San Francisco Bay Area:

New Langton Arts (1246 Folsom, San Francisco, phone (415) 626-5416) is presenting a series of three concerts for unusual instruments. Concerts are on consecutive Saturday nights at 8:00. On the schedule are: The Berkeley Gamelan, playing Daniel Schmidt's new gamelan instruments, on February 27; Tom Nunn playing electro-acoustic percussion boards on March 5th; and Kraig Grady, instrument builder and intonational explorer, on March 12.

The New Instruments/New Music concert series continues at 3016 25th St., San Francisco, phone (415) 282-1562. Concerts are at 2:00 pm on the first Sunday of each odd-numbered month. Coming up: Tim Perkis with a new MIDI-controller instrument on March 6th, and Jonathan Glasier, editor of Interval Magazine and curator of the Sonic Arts Gallery in San Diego, on May 1.





CROSET INSTRUMENTS: Pierre Jean Croset, whose work was featured in EMI's first issue, continues his work with instruments of altuglas, a plexiglas-like translucent plastic. In addition to producing instruments of great beauty, the plastic has the characteristic of being acoustically neutral. As the body of an instrument, it has minimal biasing effect on the vibrations of the initial vibration source it carries (strings, prongs, or whatever).

Pierre Jean recently sent along the photographs reproduced here. Above left are water drums; at center is an electro-acoustic kalimba; and to the right is a carbon fiber neck, altuglas guitar.

LETTERS, continued

timpani to be performed at St. John the Divine in New York City in the Fall of '88! We hope to write those "new timpani" into the piece if I can get the project funded and completed.

THE PRESENT OCCASION FOR WRITING YOU is about the TV interview on UHF 59. Jonathan [Glasier, curator of the Sonic Art Gallery in San Diego] took me to the studio up in the hills just north of here a ways. There is a weekly art program presided over by a photographer who interviews mostly painters and sculptors. This time he saw the Sonic Art Gallery and so Jonathan brought up my 8 foot megalyra and Tom Nunn's smaller kit-form Earwarg and the Wing and a few balloon flutes etc.

But here again we are face-to-face with the paradox which still puzzles me: Why progress applauded in every art and science EXCEPT music? This interviewer was evidently for all kinds of abstract ultramodern art, but wanted Jonathan to play Romantic Period music or even Classical tunes on Tom Nunn's thing, which was definitely not designed for that! And of course couldn't.

There in that environment! The latest TV editing consoles with dozens of monitors and dials to adjust them, and wall-to-wall cassette racks and tape storage bins and you name it they got it -- cameras, mikes, cables, -- satellite dishes. And then -- "I only deal with classical music" -- fortunately Jonathan had warned me carefully beforehand so I didn't make too many false moves.

Anyway some new instruments will be seen on TV screens down here.

Ivor Darreg

AN ENCOUNTER WITH JACQUES DUDON, by Tom Nunn
(continued from page 1)

preparation for this article.

Jacques began making experimental instruments in 1965 while in Nepal with a group of four other people. They had been travelling and playing music throughout India, where Jacques had gone to study classical Indian vocal music with Sri M.R. Gautam, director of the vocal department at Benares Hindu University. This group, calling itself the Rainbow Repair Shop, lived for some time near a stream, where they first had the idea to use the energy and sounds of the stream to make a continuous accompaniment for their music. When Jacques returned to France, he made, over a period of five years, more than 100 different water instruments. Those who attended his program here got to see color slides and hear a tape of many of these amazing instruments.

I asked Jacques to describe the principles employed in these water instruments. There are five: 1) water percussion; 2) water friction; 3) modulation of resonant objects; 4) water-forced air pressure; 5) modulation of resonant air volumes.

Water percussion, as the name implies, is simply water drops or water jets striking something, such as the heads of tube drums (tubophones) used in several of his rain organs.

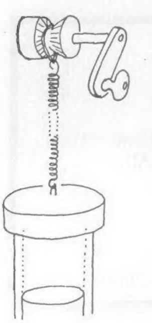
Water friction implies water functioning like the rosin on a violin bow, creating friction between a finger or other material and a glass, wood, or metal resonant object, causing it to vibrate. An example would be the **Springoviel**, which uses a spring as a vibrating object, attached by a loop of string to a rotating wet wooden spool ("viel" meaning like a hurdy-gurdy).

Modulation of resonant objects is probably something we are already familiar with. An example would be striking a metal object and dipping it in water, causing its resonant frequency to drop. Jacques' **Aquacelesta** uses bells whose depth of submersion can be adjusted with guitar tuning pegs for precise tuning. Or, the water can be used to shift the resonant frequency and harmonics of a container, as we have seen in Richard Waters' **Waterphone**. Jacques' **Aquavina** is a guitar-like stringed instrument with an open-backed metallic acoustic sound box. As it is played the box is in variable contact with the water confined in a container attached to it, thus modulating the resonance of the box, resulting in phasing and echo effects on the strings.

The fourth principle, water-forced air pressure, can be seen to function in Jacques' **Water Organs**. Essentially, a vessel with one end open and a flute at the other end is dipped, open end first, into water. As water engulfs the opening and enters the chamber, air is forced out through the flute. The **Orgue de Bac a Fleurs** is one of Jacques' instruments employing this principle. A bac a fleurs is a rectangular flower planter about four feet long, such as might go on a window sill. In the **Orgue de Bac a Fleurs**, such a planter is filled with water, and a row of "hydraulic bellows," connected to as many bamboo flutes, move into the water as they are individually pressed down by means of a simple keyboard arrangement.

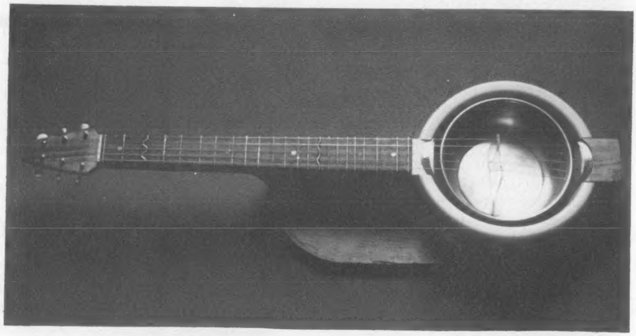
Another instrument employing this principle is the **Tambour-Oiseau-Harmonique**, a percussion instrument using very long harmonic flutes (long pipes without toneholes which articulate the overtone series) suspended vertically over a container of water. At the base of the pipe is a drum-shaped vessel. The top of the vessel is enclosed with a polyfoam lid, and the pipe passes through a snug-fitting hole in this lid. The open bottom of the vessel is submerged in the water. Within the vessel, between the surface of the water and the polyfoam above, a pocket of air is trapped; the only way out is through the pipe whose open bottom end rests above the water level. When the player strikes the polyfoam from above with a mallet, the whole assembly dips into the water, compressing the air pocket and shooting a pulse of air through the pipe, producing different overtones according to the strength of the stroke.

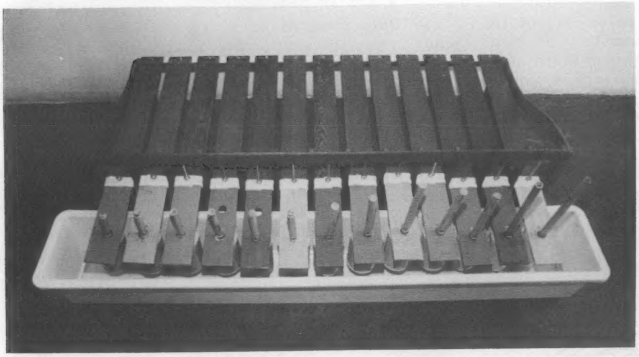
The **Aquatic Synthesizer** uses very long harmonic

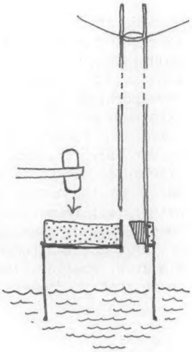


Left: Sounding mechanism of the SPRINGOVIEL

Right: AQUAVINA





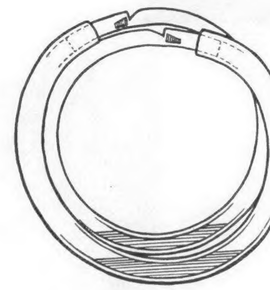


flutes partially filled with water, suspended horizontally, slightly bowed from their own weight. As their horizontal position is changed by lifting or lowering one end, movement of the water inside forces air through the fluted ends of the pipes.

In the fifth principle, modulation of resonant air volume, the size and resulting resonance frequencies of an air chamber are varied by the passage of water in and out of the chamber. This principle can be heard in the **Arc a eau** or in the **Waves Harp**, where water-modulated air chambers amplify in turn the different overtones of a set of strings. It can also be heard in the **Aqua-flutes**, whose air column length is modified by running or bubbling water in many different ways.

Top left: ORGUE DE BAC A FLEURS.
Top right: Diagram of the action for TAMBOUR-OISEAU-HARMONIQUE.
Lower right: TAMBOUR-OISEAU-HARMONIQUE being played.
Bottom left: ARC A EAU. The Arc a Eau has two strings which are sounded open. By immersing the instrument to different depths in water, the overtones of the strings are selected in turn by the changing air cavity of the resonator, allowing melodies to be played as on a jews harp. The strings can be plucked, struck or bowed (a stick in the act of striking appears as a blur to the left).

Some of the instruments use two or more of the five principles. The **Flute a Mouettes**, or "Seagull Flute," uses both the fourth and fifth principles. It is essentially a tube with a whistle incorporated in it, bent to form a circle and attached end to end, with water inside. As the circle is turned, two things happen: the water forces air through the flute mouthpiece (4th principle), and the resonant air volume is modulated as the water moves through the tube (5th principle), thus creating a cascade of descending tones. I saw a photograph showing a child holding one of these instruments; it was about two feet in diameter. However, they can be as large as six or seven feet in diameter!



FLUTE A MOUETTES. The one shown here is a double instrument, with two turns.

Jacques believes that the social role an instrument plays is as important as the instrument itself. Accordingly, he first began making pedagogic instruments for children. Then he developed instruments which children could build themselves, sort of like kits. Eventually, he developed more sophisticated instruments for use by musicians and composers, along with sound sculptures, and, most recently, instruments for commercialization.

Jacques and his colleagues have created an ingenious type of public installation they call "musical parcourse." This type of installation imposes limitations on the public that allow them to better hear what they are doing. What do people do when they first encounter a hands-on public instrument? They see how loudly it will play, of course! And what happens when you get several people doing this at the same time? Pandemonium! So, the musical parcourse is a single file **path** through a sequence of instruments that allows room for only one person at a time on any given instrument. People are given a number of activities to perform such as striking objects, pushing bellows, pressing keys, turning wheels or taps, standing on planks that are supported by floats with flutes, etc. As they do so they can see, hear and understand the effects of these actions. The parcourses are conceived in a way that the interaction of the public with the instruments creates a permanent synergic musical composition. Jacques believes that the parcourse is a better listening situation for people of any age than a course or class on how to play an instrument, because people are playing, and being watched, and heard. As such, they are, in a sense, "on stage." And this is important, for in this situation they are not only discovering something for themselves; they are also sharing something with other people.

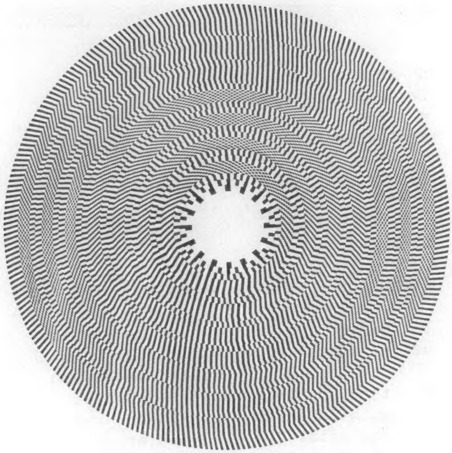
I asked Jacques if the public was inhibited in any way by this situation, and he said, emphatically, no. People would finish the parcourse and come running back to do it again over and over. At one exhibition in the South of France, as many as 30,000 people went through the parcourse!

The water instruments are special to Jacques for a number of reasons. Among others, the water, he explained, extends the nature of an instrument culturally. In his own words, "playing these instruments, you might be transported very far into the heart of some African tribe, to the Far East, as well as to different times, past or future. The water gives it that quality. It's like the water on the earth that is creating a link between all the musical cultures. It is... as if the water expressed herself, 'singing' with the accents of the earth." Also, timbrally, the water creates fascinating illusions: metal can sound like wood; flutes can sound like birds; strings can sound like electronic instruments; percussion can sound like voices. Finally, if we consider it for a moment, we realize that the sound of water is probably the most ancient and timeless sound on earth. Water must have been the first sound any life perceived, since life began in the ocean. And it must be among the very first sounds our ears encounter -- in the womb. Thus, instruments of water very likely have a stronger, deeper attraction for us than we realize.

The Photosonic Synthesizer

After developing the water instruments and the musical parcourses over a five year period, Jacques changed directions and began to investigate the use of light as a potential sound material. His **Photosonic Synthesizer** is a marvelous invention which illustrates one way in which light can be heard.

First, a bare bones description is in order. The instrument Jacques brought with him to demonstrate is the simplest one of its type he has made, and it illustrates the operating principle in a clear and direct way. It consists of a small plastic frame with a battery powered electric motor attached to a spool which spins a flexible plastic disk in front of the solar cell. The disk is transparent, with concentric patterns printed on it in opaque blue ink. It is interchangeable; different disks with different printed patterns may be used at different times. Jacques plays the instrument by holding one or two small incandescent light bulbs in front of the spinning disk, which, by virtue of the opaque patterns and transparent background, alternately blocks the light to the solar cell and lets it pass, in effect turning the light on and off very rapidly (from the solar cell's point of view). This is translated by the solar cell into electric signals which are then



SOUND DISK PATTERNS. Above: The scale of a harmonics flute. Below right: Harmonic series, with intermodolations and subtractive sounds from a harmonic series, frequency 4.

amplified by conventional means. The speed of the motor is variable, and thus functions as a tuning mechanism. And the aperture in front of the solar cell can be adjusted from a wide band of light (over an inch) to very narrow (nearly closed).

The plastic (acetate) disks, about eight inches in diameter, are printed by a computer-controlled printer. The patterns on the disks are generated by the computer using a special program written by Jacques' friend and colleague, Daniel Arfib, a computer music researcher in Marseille. The patterns not only affect pitch, but timbre as well, and are absolutely precise, being numerically generated. A disk may have a scale of any set of intervals, or it may have only one pitch, but with timbral variations, or a disk may articulate different harmonic series.

I asked Jacques how he designs the patterns for these disks. "First I should say, as the disk is spinning, each ray of light reads only one circle of the disk. The inner circles, closest to the center, have shorter circumference than the outer circles, and so we usually put the lowest sounds at the center, as they require less information than the highest sounds. In the space on the disk between the minimal and maximal radii, you have all the freedom to make scales or sound variations through graphic operations. One of the simplest possibilities is to create a musical scale, which you can generate by increasing the number of regular wave forms from the minimum radius to the maximum radius proportionally to whole numbers. The number of proportions will give the intervals of the scale."

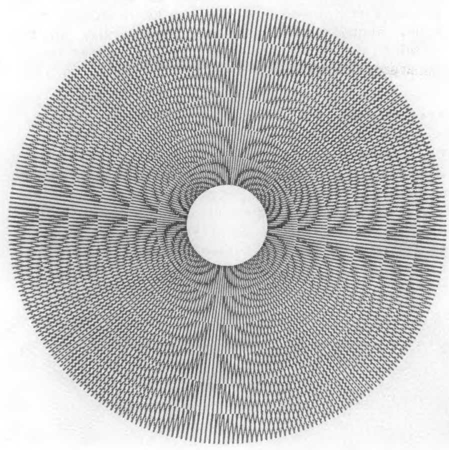
Continuing, he explained, "You can add to these fundamental sounds whatever overtones you want. At the same time, you can add their subharmonics or 'undertones,' by omitting regularly some of its signals, or creating different periodic accents. And you can work on the sounds in a purely graphic way; for instance, you can draw one sound on top of another and what you have in the coincidence between the two graphic waveforms."

Since the design of the disks is essentially a graphic operation, disks can be generated using visual criteria; i.e., drawing an interesting visual pattern, to create sound which would not occur in natural acoustics. "Kind of like optical illusions, you can subdivide the waveform and change the order of the patterns creating these waveforms, selecting segments from different waveforms, etc., or play with the numbers in any way you can think of. There are hundreds of possible graphic operations, and as many ways to create new sounds."

Jacques first began experimenting with this idea by painstakingly cutting holes of specific shapes and patterns in cardboard disks using a calculator, protractor and knife. By now, using the computer, he has created about 200 experimental disks. And each month he and his colleague are discovering new graphic operations to use.

In performance, Jacques uses eleven different **Photosonic Synthesizers**, as many as one to seven at a time. Each is different. Some have computer controlled light sources, some use candles, others use different optical and mechanical apparatus. Surely, his show must be as exciting visually as it is musically.

Currently, Jacques is the president of an organization called **l'Atelier d'Exploration Harmonique**, a group of artists and musicians researching various aspects of experimental instru-



ments. The town of Roquevaire, east of Marseille, is their headquarters. Among other things, Jacques' group has developed a new instrument which they will soon make commercially available, the **Orgue de Barbarie Photosonique.** It is similar to the traditional Barbarie Organ, a popular type of mechanical organ played by street musicians in Europe. But instead of the Barbarie Organ's mechanical or pneumatic action, the **Orgue de Barbarie Photosonique** uses light both controlling and generating the sounds, as in the **Photosonic Synthesizer.** It will be able to play the traditional accordian-fold cardboards still made by artists in Europe for the Barbarie Organ, as well as new cardboards designed to play various musical styles (oriental, microtonal, electroacoustic, etc.) with new compositional freedom. We hope that this instrument will be of interest to contemporary composers, who will be able to incorporate in their compositions various scales (having the ability to control attack, decay, intensity, pitch and timbre) that were not possible with the traditional Barbarie Organ and thus more attractive to musicians."

The town council of Roquevaire has voted to lend to the Atelier d'Exploration Harmonique a space to open a museum to the public dedicated to new, experimental light and sound instruments. Jacques explained, "When this museum opens, it will be the first of its kind in Europe. We hope to make it known to experimental musical instrument makers throughout the world, and we hope to create each year an event which will include exhibitions, concerts, and workshops concerning new musical instruments."

All of us who have met Jacques during this recent trip are glad that he was able to visit California and share with us the fascinating and extensive work he and others are doing in France. And I am certain he will report on our work to his colleagues. As others probably do, I would like to visit Jacques one day to again exchange information, ideas and music. But whatever happens, another link has been made, now, in the growing international network of experimental instrument makers, and that can only help us all!

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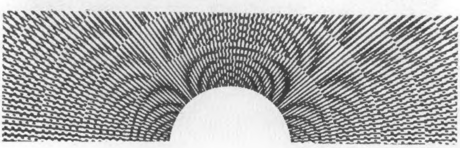
For more information on the work of Jacques Dudon and L'Atelier d'Exploration Harmonique, Jacques can be contacted at 2, traverse de la treille, 13.360 ROQUEVAIRE, France (telephone 42.04.46.05). His book, La Musique de l'eau, 108 instruments aquatiques a realiser soi-meme (editions Alternatives, Paris, 1982), is distributed by Paralleles booksellers, Paris.



THE CUSTOM MADE FLUTE
By Jim Schmidt

Jim Schmidt is a machinist, craftsman, and musician. He has recently developed a modified version of the standard orchestral flute, and in this article he describes the instrument and the process of making it.

His purpose in making the altered flute has not been to create a new instrument type but to improve the playability and tone of the existing one. Some of the changes in the new flute have to do with the form of the lip plate and resulting embouchure; others relate to the number and positioning of joints making up the tube of the assembled flute. But the most pronounced differences are in the area of fingering and keywork: Schmidt observed that it is possible to assign eleven unique values to fingers without getting into multiple digits (the values corresponding to each of ten fingers plus one more to the zeroth finger -- that is, no fingers). This means that we come up just one short of being able to cover the twelve pitches of a chromatic scale by assigning one pitch to each finger plus one to no fingers. Since the flute, like the majority of woodwinds, overblows the octave, for the most part repeating its fingering pattern after twelve pitches, it thus becomes near-possible to create a fingering pattern where the chromatic scale corresponds to the simplest possible progression of fingers, and all cross fingerings are eliminated. Schmidt has achieved this in his flute by employing both thumbs in the fingering, and, to allow for that twelfth unique value, assigning in one instance two pitches to one finger. In doing so he has also made possible considerable simplification and lightening of the mechanics of the keywork as well as simplification of fingering.

Schmidt has also applied the system to a C-melody saxophone, in this case modifying an existing instrument rather than building from scratch.

For more information on the modified flute, readers may contact Jim Schmidt through JS Engineering, 773 W. Herndon, Clovis, CA 93612, phone (209) 297-0745.

****

Having played the conventional flute for a sufficient number of years to find it in need of improvement, I decided to redesigned its fingering pattern, update its keywork and improve its acoustic tone. With the resolutions to these problems in my head, I came to my first objective: Realize it in the actual material world.

To begin with, I needed silver tubing. This is to be had from only one source in North America: Leach and Garner Co., Attleboro, Massachussets. The minimum order is 50 oz., which totaled about $350 at the time of my purchase.

Since the head of the flute is parabolically tapered, I had to fabricate a steel mandrel of exact dimensions on a metal lathe. I formed the taper out of 3/4" steel rod by a process of three increasingly tapered cuts. The stages of these cuts were then filed smooth and polished. A clamp in the form of a screw was fitted onto one end of the mandrel in order to hold fast the silver tube to be placed over the mandrel. With the tube thus in place, the combination was forced through a narrow lead hole, small end of the mandrel first, by means of an arbor press. Lubrication helps the silver covered mandrel slide smoothly through the expanding lead hole. The hole expands because of the increasing diameter of the mandrel, but is firm enough so that it shrinks down the soft silver to the underlying dimensions of the mandrel. When the entire combination had been forced through the lead hole, the silver was slipped off, and the ends of the head tube were trimmed to the proper dimensions.

Next came the installation of the embouchure hole with its chimney and lip plate.

An 1/8" hole was drilled to locate the position of the embouchure hole. Next, a chimney was looped out of an extra piece of silver and soldered with hard silver solder onto the parabolic head around the locator hole. Then an attractive lip plate was cut out of more extra silver and soldered, with medium hard silver solder, on top of the chimney. The embouchure hole was then roughed out to full size, and the entire assembly polished. My embouchure design is different than most in that it allows the player to move his lips closer to the far edge of the embouchure at which he aims his exhaling stream of air. I have found that this design allows more control to the player, and gives his acoustic tone a clearer purity.

Having finished by installing a silver-capped cork in the small end of the flute head, I moved on to building the main part of the flute: the body.

In thinking beforehand about the flute body, I had decided to eliminate the separate soldered parts of the barrel joint and foot joint connections. The foot joint was left on the body as one solid piece; it cannot be taken off. This involved simply not cutting off the extra inches at the end of the body, and using them for the foot. The barrel joint was another matter. Since the head joint must have an air tight fit which is adjustable in length to the flute body (for tuning purposes), I decided to swedge, or expand it right out of the flute body itself, so the the flute head could slip into its expanded diameter. The reward for taking such painful measures is that without the solder joint as found on conventional flutes, my flute would sound louder, lighter and purer. To exaggerate this quality, I moved the barrel joint towards the foot of the flute, away from the embouchure, in order that the head may have more room for sounding its "silver resonance", before it is deadened by the unrelinquishable barrel joint. This technique has proved very effective and satisfactory.

After the two main, beautiful shapes of the flute were completed, I came to a more difficult and tense stage; that of drawing the tone holes

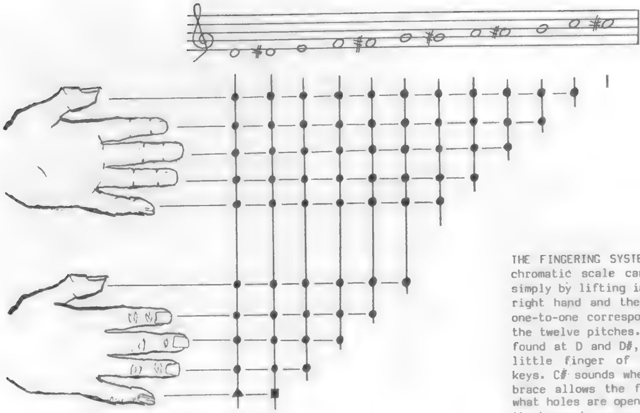
out of the main body of the tube, creating the raised level rim to seat the pads. This process is very tense because if for some reason the flange of a tone hole should crack, due to impurities in the thin wall tubing or improper preparation before drawing, you're screwed. You have to repair or start all over again with a new body.

To draw the tone holes out of the tube, it was first necessary to fabricate the needed tools. A solid bar is inserted into the tube to keep it from getting deformed during the drawing process. This bar has a hole for holding a slug of hard metal. Then a metal saddle is place over a preliminary elliptical hole that has been cut into the tube where the desired tone hole is to be drawn. The preliminary hole is small and elliptical because the sides of the tone hole will need more material in order to form a flange high enough to be filed flat to accommodate a sealing pad. In the middle of the saddle there is an opening whose shape matches the desired outside shape of the raised rim of the tone hole. After the slug in the bar is lined up to the hole in the tube and the opening in the saddle, a machine bolt is screwed into a threaded hole in the slug, and a nut is then tightened down on top of a washer over the saddle. This pulls the slug up through the elliptical hole in the tube, and shapes the extruded silver to the conforms of the saddle resting on top. The slug is then removed along with the saddle and bar, leaving a perfectly shaped chimney style tone hole. All that is left to do now is file off the excess at the top to insure a leak proof seating for the key pad.

Needless to say, the exact location and size of the tone hole is critical to the intonational accuracy of the flute. I have taken my measurements off of several quality flute makes --Armstrong, Gemeinhardt, Haines, Murumatsu, etc. -- taking into account the different diameters of tubing and variations in overall length. All these measurements were averaged out and plotted on a graph to compromise for their differences in intonation. In this way I believe I have constructed the most perfectly in tune flute in existence today.

After all the holes were drawn, I came to the most tedious and difficult task of all; that of meticulously fabricating the keywork and its fittings on supports in conjunction with interlinkages, etc. This is where the patient brain work and delicate craftsmanship is employed. It can break your back, destroy your eyesight, and make you wonder if you'll ever get done. Sometimes I say to myself, "Maybe it would be smarter for me to go out and socialize instead of waiting around for God to give me miraculous flashes of insight to see through the insurmountable obstacles of complicated machinery vs. beautiful, efficient simplicity." Slowly, ever so slowly, the finished product materializes before my eyes.

The logic behind my fingering system is straightforward. One note follows the next chromatic note by closing down the next key with the next finger of your hand, on down the line, one after the other; not here and there helter skelter as on the popular Boehm method. With my fingering



THE FINGERING SYSTEM ON THE REDESIGNED FLUTE: A chromatic scale can be played on the new flute simply by lifting in succession the fingers of the right hand and then the left, creating a simple one-to-one correspondence between the fingers and the twelve pitches. One exception to this rule is found at D and D#, which are both played by the little finger of the right hand operating two keys. C# sounds when all fingers are up. A thumb brace allows the flute to be held regardless of what holes are open or closed; the thumb pivots in the brace to open and close its hole.

system, each finger has only one job (except the right pinky which has two), and it always knows exactly what to do. This new fingering system is easy to memorize and enables the player to perform passages with greater ease and rapidity. Chromatic scales sound much smoother. Other scales can be played by simply leaving the notes that aren't played closed with the appropriate finger, and working just those fingers that produce the notes of the desired scale. All scales, with the possible exception of C major, can obviously be played more easily. The reason C is an exception is because that is the key that the Boehm method is built around, with the sharps and flats of other scales inserted wherever they can fit. Such an arrangement was fine for yesterday's music, but is obsolete today. In the new system, tones are cleaner and quicker due to the fact that each hole is independent and is not loaded down by integral linkages as are, for instance, Bb and F# in the Boehm method. Understandably, trills are a breeze to play as they simply involve the same finger as the usual note played to be moved up and down. A chromatic or other scale of successive trilled notes sounds very impressive and uniform, each note having the same loudness and available speed, according to the capacity of the playing finger. (Fingers work faster than thumbs, both of which are used on my flute. A thumb joint rest is incorporated to free the front part of the right thumb.)

The special qualities of this flute can also be seen in the free style with which it plays jazz and classical pieces. This is particularly true in jazz, because with my flute you can do things to create special effects and passages that have been hitherto impossible with the Boehm method.

There you have it. Further criticism will have to be taken up by individuals who care to study the illustrations, or the actual flute itself. If nothing else, today's manufacturers might incorporate some of my ideas for acoustical improvements, such as --

a longer head joint, and no foot joint or barrel soldering joints;

use of new materials and designs in the keywork such as: elimination of posts which have been replaced by one-piece bridges, elimination of key stop arms, and a general reduction of deadening weight and messiness, thus enabling the flute to sound louder, clearer and more sensitively;

and improvements as to the use of more durable rubber pads. These pads are leakproof and reduce the most troublesome aspect of flute maintenance to an occasional adjustment.

Regardless of what innovations of mine might be employed by the musical society -- the fingering system, the construction or whatever -- I believe I have made for myself a flute as fine as any, which should help me to advance my channels of communication through music in the free time I have to play, practice and perform.

Joy and harmony come to he who is a musician, because joy and harmony exist between him, his instrument and those who listen.

TRAVEL INSTRUMENTS

In recent years, miniaturization has done much to make the material trappings of our culture more manageable. Such things as information storage systems and all manner of electronic hardware have become less space-consuming and more portable, to our great benefit. Some things don't reduce well though. Among them are many musical instruments. The reason for this is that the size of an instrument is frequently an essential factor in the creation of its characteristic sound waves. Some people, nonetheless, have taken on the challenge of making more portable the act of making music.

This three-part article looks at attempts to render various standard instruments more transportable. The first part gives a broad overview, bowing to a number of diverse instruments adapted for the road in the past and present. The focus becomes more specific with the second and third parts, contributed by two current designers and builders of travel instruments. Each describes how he has gone about making particular instruments more portable -- cello in one case, and guitar in the other -- without compromising quality.

Special thanks for assistance with this article go to Lark in the Morning, music store and center for musician's services which carries an extensive stock of unusual and hard-to-find instruments & accessories (PO Box 1176, Mendocino, CA 95460; (707) 964-5569; write for newsletter and catalog).

THE GRAND PIANO IN A MARCHING BAND
by Bart Hopkin

Some instruments are so light and convenient they can go anywhere. Harmonicas, Jew's harps and bull roarers all can be carried in a shirt pocket like a pet hamster, for a day's hike or a longer journey. Various small flutes, ocarinas and recorders are just as convenient. There are tiny pendant ocarinas, only two inches or so across, that can be worn on a string around the neck. Alternatively, you can carry mallets and let the world become your instrument. Superball mallets are good because their midrange hardness is acceptable for many idiophonic objects, plus they have a remarkable ability to elicit unexpected sounds from glass and metal by friction. Some instruments -- reed flutes, leaf oboes and others -- are so easily made from commonly-available materials that, in the right circumstances, there might be no need to carry them at all. And finally, there is arguably the finest, and indisputably the most portable of all instruments, the human voice. In the same vein, we should not forget the honorable art of body percussion.

But the world is full of bigger instruments as well, and many people are committed as performers to such instruments. There are plenty of times when one might wish an instrument weren't too big to walk with, to fit under an airplane seat, or to carry conveniently on the city bus. We will look now at some approaches people have taken to making larger instruments more portable.

Among the first instruments to develop serious weight problems were pipe organs. An early example of the deliberate modification of an existing instrument type specifically to make it more travel-able is the portative organs of 14th and 15th century Europe. The term "portative" has been applied in varying ways over the years, and to organs of varying degrees of portability. The most portable, depicted in a number of Venetian renaissance paintings, were very small but fully functional pipe organs that could actually be carried and played while standing or walking. (Compare that to the cathedral organs of the ensuing centuries and the distinction between portative and positive begins to take on some meaning.) They were held by a strap over the player's shoulder. Normally the keyboard was operated by the right hand, while the left worked the bellows. The range was an octave, two octaves or more, often fully chromatic, and there could be one or more ranks of pipes. The longest of the pipes might be two or three feet.

In the following centuries there were also reed organs (using free reeds, similar in principle to those used now in harmonicas) made without any sort of pipes or resonators. They were as compact as the smallest portative pipe organs, though not designed to be played in motion. These Regals, as they were most often called, had a keyboard in front and a pair of bellows (operated by someone other than the player) in back. They sat on a table top, and might be small enough so that one instrument, folded up into itself, could take on the appearance of a large bible -- thus the term "bible regal."

One of the reasons that clavichords gained acceptance in Europe was their inexpense and ease of transport. But when harpsichords came into their own, and especially as they became increasingly elaborate and stringing tensions increased, the problem of immobility arose again. There were, of course, smaller and simpler harpsichords built. The virginals (usage of this term too has been inconsistent over the years) were usually made to sit on a table top and were sometimes not much bigger than an average clavichord. But a more drastic approach to the problem of size can be seen in the Clavecin Brises ("broken harpsichords") built around the turn of the 17th century by the Parisian builder Jean Marius. These were full-sized, fully strung harpsichords (minus legs) which were actually built in three separate sections. The sections were hinged together, and with the keyboard removed, the whole could fold up into a rectangular box of moderate size. The jacks, normally wooden, were in Marius' instruments made of lead, to reduce sensitivity to climatic changes that might be encountered in travel.

Substituting, for the moment, the crank for the keyboard, we can mention here the street organs, or barrel organs and barrel pianos, that were popular in the 19th and early 20th centuries. The organ grinder with his monkey busked in city streets in Europe and America using an instrument

that had probably been made by one of several firms in England. Some of these instruments were small enough to be carried about by hand, perhaps supported by a neck strap and a single upright stick, as the organ grinders moved from place to place. Slightly larger instruments were set in big-wheeled hand carts, enabling the itinerant musician to be more readily itinerant. Some very fancy ones were built into a special horse-drawn cart.

Another wedding of the organ and its vehicle was achieved in the riverboat steam calliope. Beginning in 1850 and continuing well after steam calliopes had fallen out of favor on dry ground, the natural affinity between steam boat and steam organ gave rise to a special American form of water music.

In the time since the decline of steamboats and organ grinders, the need for travel-able keyboards has continued to assert itself. I have sometimes thought it surprising that a small chamber-piano of one form or another has never gained much popularity, but recently many other forms of light keyboards have. Free reeds have always been a great way to achieve maximum volume with a minimum of equipment, and a few years ago they appeared in keyboard form once again, this time in the melodicas and pianicas -- essentially keyboard-ized harmonicas -- made by Hohner and others firms. These are plastic instruments, consisting of keyboard and soundchest scarcely larger than the space actually occupied by the keys, sounded by air blown through a flexible tube. Their range is from an octave and a half to about three; they fit in a case about the size of a flute case, they are extremely light and durable to boot, and, I found a while back, they were inexpensive enough to put one in the hands of half the kids in a public school music class without severe damage to the department budget.

They appeared on the eve of a great surge in popularized, inexpensive electronics, however, and seem to have been superseded now by a variety of Casio keyboards and their clones. These, as everyone must know by now, are one of the great triumphs of modern miniaturization. However sentimental one may be about acoustic sound, the convenience and capabilities of the inexpensive new electronic keyboards are undeniable, and have been a great boon to a lot of people.

And for sheer elegance and style as well and portability and convenience in miniature electronic keyboards, we must not overlook Laurie Anderson's famous necktie.

Let us now move back again in time to look at some efforts that have been made to make non-keyboard instruments more travel-able.

In 16th and 17th century Europe there were people who served as dancing masters, refining the skills of the adults and children of royal courts and wealthy families. The dancing masters often played what were called kits, or pochettes. These instruments functioned like violins, using similar technique and playing similar (though usually simpler) repertoire, but they were tiny enough to fit in a coat pocket. Marin Mersenne (in Harmonie Universelle, one of the primary surviving sources for this sort of information) suggests that this is where the name pochette comes from -- the instrument was, in effect, a pocket fiddle, and very convenient as such to a travelling dancing master. Mersenne's observation has perhaps led us since to an overly narrow perception of its use, however. Kits are known to have been used by all social classes, including some of those who might have valued its compactness most: wandering fiddlers, and shepherds.

Kits were made in a great variety of shapes. Some had more or less oval bodies; some were stick-like, with the body scarcely broader or otherwise differentiated from the neck; some were much like sloped shouldered viols; and some took the form of tiny, narrow violins. The forms were generally much elongated, so that a string length of perhaps 12 or 14 inches could be carried on an instrument no more than a few inches across at the widest point. While it seems natural to think of kits as miniature violins (many violin makers, Stradivari among them, made kits), it can be argued that their genetic history links them more closely to the smaller and narrower rebecs. The form of early kits seems to bear this out. Kits naturally have considerably less projection than their larger relatives, but apparently the tone was adequate to the purposes for which they were used.

In the mid-18th century one Johann Wilde created a kit made in the form of a walking stick. In the next century this flowered into an unlikely fad, in which every instrument that could be coaxed into something like a linear shape was incorporated into a walking stick: there were walking stick bassoons, clarinets, oboes, flutes recorders and trumpets. Various people continued to make walking stick violins as well, and I recently came across a newspaper article about someone still doing so. (Unfortunately, that article didn't get saved, and I have no details.) A walking stick flute, based upon a historical instrument now in the Boston Museum of Fine Arts collection, is also currently being made commercially and is available through Lark in the Morning (address given at the start of this article).

In another 19th century experiment, one Daniel Fuchs in Vienna built a trombone with detachable bell, which he called the Traverson.

Another area in which miniaturized instruments have evolved is that of guitar-like plucked strings. There are several traditional varieties of small guitar (traditional, that is, as opposed to something that might be the product of an an individual's deliberate innovation -- though this distinction is not always a clear one). One example of a small folk guitar is the charango, found in the Andean regions of South America. It has a total length of between 45 and 65 cm, and a very small, guitar-shaped soundboard. The shallow body may be flatbacked or roundbacked, the latter often being made of armadillo shell; sometimes of gourd or carved wood. That there is a connection between its size and a need for portability is suggested by the fact that its distribution follows trade routes used by muleteers.

In Portugul are small guitar-shaped instruments known as Cavaquinho or Machete. They have travelled with sailors and been localized in various parts of the world. The most familiar of the new

world Cavaquinhos is the ukulele in Hawaii; equally important but less widely known in northern climes is the Cuatro, used on the eastern side of South America and in the Caribbean. Whether there is a direct connection between the need for portability and the popularity of these smaller instruments is a matter of speculation.

A portable full-sized guitar was designed in the early 1950s by Francois Baschet of Paris. Baschet discovered that balloons, if designed properly, can make effective sound radiating surfaces. He designed an instrument with a standard neck and an inflatable body to accompany him in his travels. That remarkable instrument is described in an article on the work of the Baschet Brothers which appeared in EMI Vol. III #4.

More recently, a number of builders have been making travel guitars in various designs. One is the Nova Guitar, made by the Genesis Nova Corporation and available through Lark in the Morning. It is designed to have playing action identical to a standard classical or steel string guitar, but it is fully collapsible to fit into a narrow, 21" long tote bag. The sound board is a piece of mahogany about 5 or 6 inches wide at its widest point. The board is thick enough to support the strings on its own, for there is no soundbox; the soundboard alone is the entire body. To duplicate the feel of a full sized guitar's soundbox, there are four mahogany arms that fold out from the board, filling in at the points where the player's arms and lap would normally contact the guitar's body. The neck is made to fold on a specially designed hinge, doubling over the body. The instrument is intended primarily as a travelling practice instrument, but a transducer is built into each instrument for increased volume should that be called for.

Another compact guitar is the McNally Backpacker's guitar, with standard playing action but a greatly reduced soundbox for overall dimensions of 32" X 6" X 2" (no hinged neck on this instrument). The Vagabond guitar, developed by Kevin Smith and available through Lark in the Morning and In The Tradition (PO Box 223, Deer Isle, ME 04627), takes an approach similar to the McNally instrument, with a very prettily designed undersized sound box. Yet another travel guitar is the Packaxe, discussed in more detail in the third section of this article.

A Backpacker's Mandolin, 20" long and 1½ pounds in weight, is made by Leo Instruments (also available through Lark in the Morning, address above). The design is derived from piccolo mandolins known in Europe around the turn of the century.

There are surely many more travel instruments beyond those mentioned here. Many people reading this article will be reminded of different approaches to carry-along music that they have encountered or dreamt up. But we will stop our overview here, in order to take a closer look at the work of our two featured builders, Francis Kosheleff and Ernest Nussbaum.

TRAVELING WITH THE TRAVIELO

By Ernest Nussbaum

If you play the flute or oboe, traveling with it is easy. The instrument takes up only a corner of your suitcase. With a violin or viola the problem becomes noticeable, because then there is an additional piece of luggage; but you won't be stopped from taking it on an airplane.

There is a very real problem as soon as you get to a cello or other instrument of that size. In the family car it needs either the right front seat or the entire rear seat (it won't go into the trunk of many small cars). On an airplane one usually has the choice of checking it or buying an extra ticket. The former may result in a damaged cello; the latter is expensive even if the instrument travels at half fare. Occasionally an airline will still let it travel free, but only if there are empty seats.

Although the problem of traveling with the larger instruments has become more bothersome with the coming of air travel and compact cars, it has been around a long time, and people have been designing "collapsible" guitars and cellos ever since the leader of the camel caravan told Marco Polo that he would have to leave his organistrum behind. U.S. patents have been issued during at least the last hundred years for folding violins and guitars, collapsible double basses, and so on. For some reason, there seem not to have been any patents for collapsible (or foldable, inflatable, demountable, etc., etc.) cellos as such until recent times.

This does not mean that there were no such instruments. Many ingenious souls have devised their own "travel cello," and there seems to have been a British company 25 or 30 years ago that sold what was known as the "Portacello." Designing such a cello is relatively simple if it is to be just a practice instrument with no requirement for a full or especially beautiful tone. The design becomes more difficult if the cello is too be useful in "real" playing. Several problems must be solved in either case:

1. Assembly and disassembly of the instrument should not be too difficult or time-consuming, or no one will want to use it.
2. The disassembled instrument must be compact, but when assembled and being played it should feel exactly like an ordinary cello.
3. The instrument should be sturdier than a conventional one, at least to the extent of not coming apart in high humidity or cracking when exposed to temperature extremes.
4. The first three problems must be solved even for a practice cello, but if one wants to play chamber music in distant places there remains the problem of tone quality.

The violin makers of Cremona discovered how to achieve good tone quality four hundred years ago. Many factors are involved, but the material and shape of the body are among the most important. There have been many attempts to build violins (and other members of that family) with shapes other than the traditional one, and from substances other than spruce and maple.

string height quite easily and has worked well ever since. Other standard components include fingerboard, bridge, endpin, tailpiece and steel strings.

At the beginning I tried to use a guitar transducer to connect the prototypes to an amplifier, but it did not work well. Eventually I learned that special transducers are available for the violin family. They attach directly to the bridge (not the body). Since the string vibrations are thus picked up off the bridge, as it were, rather than the body, it seemed that the material from which the body was made should not matter.

That turns out not to be so. I discovered that a vestigial body -- two sides and not much else -- vibrates considerably when the strings are bowed, and feeds certain overtones back into the transducer. The nature of those overtones appears to depend quite a bit on the material and its thickness. Almost by accident it happened that the third or fourth prototype was made from thin spruce planks. With this spruce body, the proper transducer, good strings (which brand one uses can make a tremendous difference), and the right sort of amplifier, the instrument suddenly sounded like a decent cello.

Further experimentation led to the design of a compact battery-operated amplifier. It had to have just enough power, have the right amount of

A cigar-box violin or cello made of plywood, for instance, is much easier to build than the conventional type. But it doesn't seem to work; one sees very few cigar-box violins being played. Inexpensive student cellos and double basses are made from molded plywood, but no one claims that they have great tone quality.

I was not unaware of these problems when I first thought of making a "travel cello" a few years ago. As an amateur cellist I had often wanted to take the instrument along on trips, so that I could use the directory of the Amateur Chamber Music Players and make new friends in distant places. (If you've ever known any chamber music buffs, you know that we are addicts and get severe withdrawal symptoms when deprived of quartet playing for more than two weeks.) But taking the cello on air trips is usually too expensive, and even when the trip is by car there can be difficulties such as the mother-in-law who objects to riding in the trunk or on the roof just because the cello needs one of the seats.

The idea of some simple frame on which to stretch cello strings, and of making the neck detachable to reduce length, seemed fairly obvious. A cello touches the player's body at only two or three points, so the use of a narrow rectangular shape with detachable extensions to simulate those points also seemed obvious.

My first two "prototypes" were made of ¼" plywood. Both were about 5" deep and 29" long (the approximate depth and length of a normal cello body) but merely five or six inches wide. The soundbox of one prototype had only sides and ends; the other had a top and bottom also, i.e., it was an enclosed box. Even the open shape sounded recognizably like a cello, but it had a rather thin sound, as one might expect. The closed box produced much more noise, but it did not sound exactly beautiful. A cigar-box cello shape evidently produces many unpleasant overtones.

For those early models I used a ready-made precarved neck, which is available from the supply houses. There are various ways for attaching the neck so as to make it easily demountable; by pure luck I picked one which allows for adjusting the

gain and input impedance for the transducer, and fit into a very small box. Fortunately there are now many integrated circuit chips available; 20 or 30 years ago such an amplifier would have been quite difficult to make.

It remained to proportion the overall design so as to make the carrying case (which doubles as acoustic enclosure for the loudspeaker) small enough to qualify as carry-on luggage during air trips. The criterion for this on most domestic airlines is that the combined length, width and height must not exceed 45". It was also desirable to keep the length of the case under 31", because that is the fore-and-aft space available under most airplane seats. (Actually, it's easiest to put it into an overhead compartment.) So the case ended up being 6½" by 7½" wide and high; 31" long. If it were much shorter there would not be space to store a bow! There are no good collapsible bows on the market at present.

All this was not very difficult. However, to "shoehorn" the disassembled instrument into the case it was necessary to shorten the conventional pegbox and omit the scroll. (That is perhaps the only part of a conventional cello which is purely decorative.) Special short pegs were also designed so that they would not have to be removed every time the instrument is taken apart and stored in the case.

Although the strings have to be completely relaxed when the neck is removed from the body, they are permanently secured to the tailpiece. This device and certain others make the reassembling as well as tuning of the Travielo much less onerous than one might think -- it takes only five minutes.

The fingerboard and string length are standard and when being played the instrument feels quite like a normal cello. The whole thing weighs about 15 pounds. If the speaker and amplifier are omitted, the instrument becomes an easily transported practice cello weighing less than eleven pounds. One can still attach a transducer and produce a full tone by connecting to a home hi-fi set or regular music amplifier.

In summary, the Travielo started out as an "Experimental Musical Instrument" although the idea was to duplicate the tone of a conventional cello. At this time it is no longer quite so experimental, but as with anything that is only a few years old there is still room for improvement.

Information on the Travielo may be obtained from the author at 6009 Johnson Ave., Bethesda, MD 20817; telephone (301) 530-7356. The finished Travielo sells for $825, practice cello for $460. Plans/drawings for the Travielo are available at $25.

THE BIRTH OF THE PACKAXE
By Francis Kosheleff

This article is an updated version of one which appeared in Guild of American Luthiers Quarterly Vol. 9 #2, June 1981, copyright 1981 by the Guild of American Luthiers.

Twelve years ago after reading an article in **Guitar Player** about the hassles of traveling with a guitar, and remembering my own camping trips in Europe and the United States, it dawned on me that the answer was a folding guitar. That night I went to work on that idea with pencil and paper, slept over it, dreamt about it and the next morning started working on it in the shop. The following Saturday I went to the San Jose Flea Market and bought several cheap, broken acoustic guitars to experiment with. Later on that month I started the actual construction of the first folding guitar and named it the **Packaxe**. The name **Packaxe** is now trademarked.

The idea of having a hinged neck on a guitar is not new. I suspected it must have occurred to many luthiers before me, and yet I had never seen a folding guitar, nor had I ever read or heard of one. When I talked to knowledgeable people about it I was usually told that such an instrument could not possibly work for a hundred reasons.

I went ahead anyway building several types of guitars with folding necks, and sure enough, there were problems, lots of them, but for an inventor this is a challenge to be enjoyed.

When I decided to patent these new guitars the first step was to do a search at the Patent Library in Sunnyvale to find out if there were any existing patents on folding guitars. This was an experience! I spent days poring over books and files going back almost to the beginning of the century and found a number of patents on folding guitars. Now I know why the folding guitar never became a hit. Some of these inventions were quite clumsy and acoustically unsound. I suspect the inventor did not realize that the purpose of a guitar is to play music. A couple were on the right track but stopped short of a workable solution, probably because they did not actually build a folding guitar after they designed it. They would have found out all the things that can go wrong in the process.

The first thing to cause trouble is the tendency of the strings to spill out in all directions when you fold the neck, and subsequently to refuse to go back to their proper place when unfolding it. The remedy is simple enough. It consists of redesigning the nut, creating a higher nut with holes instead of grooves, with a zero fret in front of it.

The second problem with the folding neck is that no commercially available hinge is perfectly suited to the job. Some can be modified or adapted. I will describe each of them with each type of instrument.

The third drawback is the inherent instability of a folding instrument due to the abrupt changes of tension when folding and unfolding. This will cause changes in the action and the intonation of the instrument that can be cured by designing an adjustable locking device for the neck which holds

it securely in position for playing. On the other hand an adjustable truss rod is not recommended because it would require adjusting every time. I favor building a laminated neck of maple and mahogany or other stable hardwoods, with graphite epoxy laminations or metal reinforcing for steel string guitars. The body of the instrument has to be sturdy and the gluing surfaces increased slightly to withstand the sudden jump from zero tension to full tension.

The fourth problem encountered is that nobody believes such an instrument can work. The only solution to that one is to let the unbelievers play the Packaxe for a while. One problem especially, I was told, would be the quality of the sound because in a normal guitar the neck is rigidly attached to the body and plays a very definite part in the acoustic quality of the instrument. It was felt that this could be lost with a hinged neck. For awhile I too was afraid it was a problem until I built the first good Packaxe and discovered there is no such problem. With a proper hinge, lock and adjustable stop screws, and under the tension of the strings (even nylon strings) the neck is as rigid and secure as with any normal guitar and plays its proper part in the acoustic scheme.

Another would-be problem that is not is the need for a string tensioning device. The idea was that in order to fold and unfold the neck you need to slacken the strings, and since to do it individually with the tuning machines would take forever, you had to invent a device that would accomplish this quickly on all the strings at once. Indeed there are several patents for such devices. From the beginning I was not convinced of the need for it, and my very first experiment with a Flea Market guitar dealt with this problem. I found that even with the heaviest steel strings I was able to unfold the neck with little effort and without damaging the guitar.

Types of Packaxes

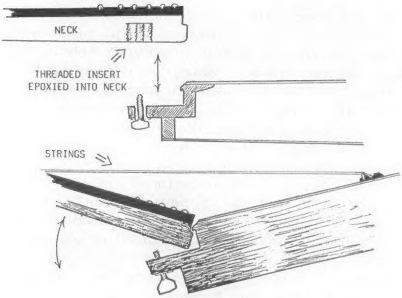
All types of guitars, acoustic and electric, can be designed with a folding neck. Some are more practical than others. Within each type, many variations are possible and the choice of locking device, hinge, shape, size and material will depend on the intended use of the instrument. For example, I have built several classical guitars that sound and look like any other classical guitars except for the hinged neck. They are designed to be used in the normal fashion with the option of folding for an occasional trip.

At the other extreme I have a model that is designed for rough use, camping, backpacking, constant travel, and it fits under the seat of an airplane. It is tough, it can be folded and unfolded in a second, and it needs only the protection of a cloth bag to carry it around.

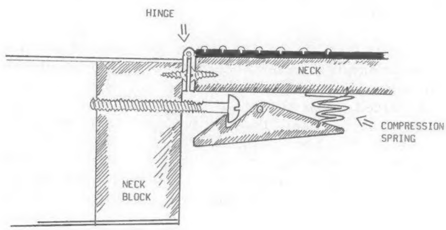
I will not attempt to describe all the types of Packaxes that I have built so far. Rather, I will show the different parts, their advantages and disadvantages and how they relate to each type of instrument.

Hinges: Regular plate hinges or cabinet hinges can be used, however the loose pin type should be avoided since the pin can drop out when the neck is folded. When the hinge is in the middle of the fret board it is located between two frets. It must be recessed below the surface so as not to interfere with the strings, but this will prevent the neck from folding all the way to the soundboard. It must, therefore, be altered to allow it to slide out of its recessed position. I file the three screw holes on one side of the hinge so they become long slits running perpendicular to the hinge pin. This will allow it to slide in and out. The mounting screws are $\frac{1}{4}$" carriage bolts with a spring washer and a nut on the other side of the neck block, inside the body of the instrument. When the hinge is at the end of the fingerboard it is not necessary to alter it since it can be mounted flush with the fingerboard on one side and higher than the soundboard on the other. It will thus allow a full 180 degree swing of the neck. With a flat fingerboard the crown of the

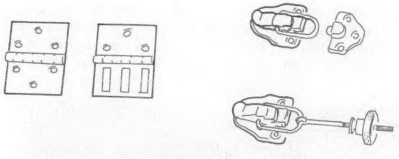
PACKAXES of differing designs.



A mechanism for hingeless detatchable neck.

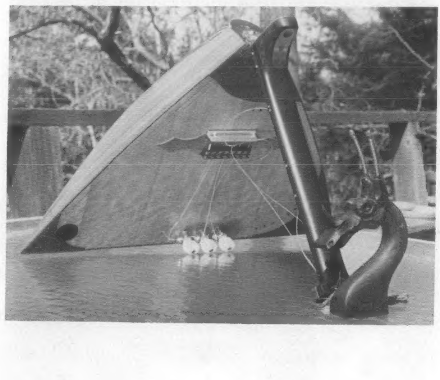


A locking mechanism designed to hold a hinged neck in playing position.



Hardware before and after modification for use on Packaxes: at left, a sliding hinge, and at right another neck-locking mechanism.

Above and below: Two cittern-shaped guitars and a balalaika.



hinge can even be used as an extra fret.

Plastic hinges can be used. I make my own out of a sheet of polypropelene plastic, which I cut to the exact size of the neck. I use them only on Packaxes where the fret board ends at the hinge. Their main drawback is that they have no resistance to twisting.

One other hinge I use is the so-called invisible hinge. It is designed to be mounted below the surface and still allow a full 180 degree swing. It is difficult to mount on a guitar neck because it must be recessed into the end of the neck, just below the frets with no room to spare on either side. The process allows for no mistake in drilling and cutting. Like the plastic hinges, this type has no resistance to the twisting of the neck that can occur in playing and therefore the locking system must be absolutely secure.

An alternative to the use of a hinge for the neck which I am using more and more is to do away with the hinge altogether and have a completely detachable neck. It is a more flexible package with obvious advantages for packing, and it also makes it very easy to adjust the action with thin

shims. Another advantage is for those musicians who like to experiment and play on unconventionally fretted fingerboards (just intonation and others) and still want a conventional fretboard for normal use. They can have two or more interchangeable necks for the same instrument.

Locking Mechanism: Because of the need for adjustment of the action, no commercially available locking device is usable without alteration. I have designed at least a dozen practical systems for locking the neck in position. I make them in my shop since they require only a few metal working tools. There is, however, one commercial latch that I use with only minimum alteration. It is called a draw latch and there are two ways to alter it or make it adjustable. See the pictures.

On several models of **Packaxes** where a low profile is desirable when folded, the heel can be drastically shortened and the peghead built in a straight line with the neck. With the tuning machines reversed, facing the front, another inch or two can be saved.

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For more information on the Packaxe, contact Francis Kosheleff at PO Box 634, Los Gatos, CA 95031; phone (408) 354-5291. A booklet describing the packaxe in more detail is available.

RECORDINGS

RECENT MUSICWORKS TAPES

Musicworks, the Canadian Journal of Sound Exploration, is a triennial publication appearing in two parts: printed journal and accompanying cassette tape. It is published by the Music Gallery, 1087 Queen St. West, Toronto, Canada, M6J 1H3; subscriptions are $22 in Canada; $26 elsewhere. Back issues, including tapes, are available.

Since EMI reviewed **Musicworks 30: Sound Constructions** in 1985, the **Musicworks** people have continued to print a lot of articles touching on new and unusual musical instruments, and featured many of them on the cassette tapes that accompany each issue. In this column we select from the wealth of material on these tapes to note some of the performances which are likely to be of special interest to EMI's readers.

On MUSICWORKS 31: WOMEN VOICING, two excerpts from **In Motion**, composed and performed by Gayle Young.

Columbine is a steel conduit marimba which Gayle Young has built and tuned to her own just scale. **In Motion** uses two pre-recorded Columbines and one played live. The pre-recorded Columbines both play the same slow melody at very slightly different tempos. The live one responds to the interaction of the other two. A lovely piece; Young's chosen tuning is very warm and comes through unhindered here. On this recording the sound of a flowing stream is superimposed.

On MUSICWORKS 32: ATLAS OF SCORES, **Solo** by John Zorn, **Piano Animation Projection Piece** by Sharon Cook, and **Solitary Waves** by Gordon Monahan.

John Zorn's **Solo** is one of a set of short improvisations recorded in 1984. It is performed using clarinet and saxophone instrument parts, a variety of animal calls, and a bowl of water. The remarkable thing about this piece is that a single performer can produce so many different sounds in such rapid succession.

Sharon Cook's **Piano Animation Projection Piece** is a form of prepared piano music. On the tape can be heard the sound of piano strings with rattly things interfering enough to buzz a lot but not kill the sustain. What makes the piece interesting is what the audience sees in performance. The upright piano is stripped down to a bare skeleton, so that a light can be projected through from front to back, with only the strings intervening, thus casting a striped shadow on a wall behind. Cutout figures -- fish and bird silhouettes and such -- are taped to the strings or suspended by wires from the hammers. When the instrument is played, the shadow figures dance on the wall, and the player, according to the composer's prescription, responds improvisationally to their movements.

Gordon Monahan's **Solitary Waves**, an excerpt from **Piano Mechanics**, actually uses no new instruments, being rather an acoustic exploration on a conventional and un-prepared piano. It is comprised primarily of very rapidly reiterated strokes (500-600 strokes per minute) upon a single very low note on the piano. Certain harmonics become very prominent, their presence made more conspicuous by the fact that little else happening to attract attention. In addition, peculiar swells and diminuendos appear, arising from shifting interference between the slow (by acoustic standards) vibration of the string and the fast (by mechanical standards) striking of the hammer.

On MUSICWORKS 33: STARTING ALL OBSERVATIONS FROM SCRATCH, **Tensegrity Sound Source #5**, by Andrew Culver.

Tensegrity Sound Source #5 is an electro-acoustic chordophone & idiophone. It has steel strings on a geometric metal frame. The sound, taken from contact microphones on the metal frame, has a peculiar envelope and is recognizably different from electro-acoustic strings on wood or other materials; the builder/performer credits the special quality to "the manner in which its tension members freely sustain its compression members."

On MUSICWORKS 36: ROCKS & WATER, an excerpt from **Changing States**, by Richard Lerman.

We have here one of Richard Lerman's remarkable microsonic explorations. For this piece he has attached small disposable pickups to metallic materials such as aluminum sheets and steel wire, in order to amplify their tiny internal sounds as he subjects them to extreme heat with a blowtorch. Some passages do indeed sound like "changing states," i.e., what one might imagine as the sound of metal melting; others are have a more percus-

(continued on page 20)

Listed below are selected articles of potential interest to readers of **Experimental Musical Instruments** which have appeared recently in other publications.

ANALYSIS OF "LIVE" AND "DEAD" GUITAR STRINGS, by Roger J. Hanson in **Journal of the Catgut Acoustical Society #48**, November 1987 (112 Essex Ave., Montclair, NJ, 07042).

The author of this article performed spectral analyses on overwound guitar strings. The tests showed major differences between new and old strings in decay times for upper partials. The differences are attributed to foreign matter between the turns of older strings. Scanning electron microscope photographs reproduced in the article show with striking clarity the presence of such matter.

HOW WELL DO WE UNDERSTAND HELMHOLTZ RESONANCE? by Richard Sacksteder, also in **Journal of the Catgut Acoustical Society #48**.

This is a short discussion of the present state of our understanding of what has come to be called Helmholtz resonance -- the capacity of a nearly enclosed air space (which need not be tubular) to respond selectively to a specific frequency. It is a common and, to anyone interested in musical instruments, important phenomenon, but it remains incompletely explained and has eluded mathematical predictability.

MOUNTAIN MAHOGANY: A DOMESTIC ALTERNATE FOR EBONY? by John A. Abbott, also in **Journal of the Catgut Acoustical Society #48**.

The author suggests mountain mahogany (cercocarpus ledifolius) as an excellent local substitute in instrument building for increasingly rare exotic woods. He compares its specific gravity and hardness to several other hardwoods and finds it in the same range as ebony.

THE THEORY AND DESIGN OF A MULTI-INTONATIONAL METALLOPHONE by Gayle Young, in John Scoville's "Instrument Innovations" column in **Percussive Notes** Vol. 26 #1, Fall 1987 (Box 297, 214 W. Main St., Urbana, IL 61801-0697).

Gayle Young explains the construction, tuning and notation system of her Columbine, a metal tubing marimba.

SOUND ASLEEP: DREAMING OF MUSIC, R.I.P. Hayman interviewed by Gordon Monahan in **Musicworks 38**, Spring 1987 (1087 Queen St. West, Toronto, Canada, M6J 1H3).

R.I.P. Hayman talks about his sleep-music events, which include some unusual sound techniques such as those employing soldering irons and hot nails on dry ice to create wailing sounds.

ELLIOTT SHARP HONES HIS AXE by David L.L. Laskin, in **Ear** Vol. 12 #8, November 1987 (325 Spring St., Rm. 208, New York, NY 10013).

Elliott Sharp is an avant-garde musician, based in rock but much expanded. This article discusses his music and touches on several of his unconventional sound sources -- prepared and altered guitars, things called slab, tubinet, nailimba and violinoid, and other mostly electro-acoustic creations.

SPINNING IN THE VINYL BONEYARD by J. Dean Kuipers, also in **Ear** Vol. 12 #8.

This article looks at the music of Christian Marclay, virtuoso of hand manipulated record turntables.

RECORDINGS, continued from page 19

sive quality. In this exotic aural context the sound of the audience's applause -- originally not recognized as such -- turns out to be one of the strangest sounds of all.

On MUSICWORKS 37: MECHANICAL DISTURBANCES, ESPECIALLY IN THE AIR, an excerpt from **Duration**, played on the Long String Instrument by Ellen Fullman; improvisations on Varion and Fleur d'Esprit by Tom Nunn; an excerpt from **Study in 11/9** by Gayle Young, **Plastic Would II**, played on Plastic Would by members of the group Sonde, and an excerpt from **Allo a l'Eau**, also by Sonde, played on the New Water Tree.

Ellen Fullman's extraordinary longitudinally-vibrating Long String Instrument and Tom Nunn's wonderful electro-acoustic percussion boards and balloon-footed space plates have appeared in EMI and its tapes; here on the **Musicworks** 37 tape is one more opportunity to hear them.

Gayle Young's Amaranth is a Koto-like bowed or plucked zither with multiple movable mid-string bridges. The placement of the movable bridges for a particular piece physically reflects aspects of the tuning system being explored. The piece presented here centers on the interval 11/9, which is a "neutral third" (347 cents; midway between a major and minor third in 12-equal temperament), and has further implications for Young in that it is almost exactly half of a perfect fifth.

Sonde is a Canadian group (Charles de Mestral, Pierre Dostie, Chris Howard and Robin Minard) whose pieces are created as sonic explorations of particular instruments they have built. On this tape we first hear Plastic Would. It incorporates small sheets of wood, mylar, polyethylene, and synthetic rubber, which have in common a dry quality to their sound. Vibrations are excited by friction and percussion with fingers, bows and sticks. Contact mics on the frame of the instrument amplify the sounds. The New Water Tree which follows on the tape is a musical fountain, with circulating water gurgling, flowing and dripping down through an adjustable series of metal basins. The mixture of flowing water sounds and the metal pan drip-drip sounds is quite musical and lovely.